Technical Report 586

COOPERATIVE LEARNING: IMPACT ON ACQUISITION OF KNOWLEDGE AND SKILLS

Donald F. Dansereau
Texas Christian University

BASIC RESEARCH

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During the first year of the contract we have completed three sets of experiments and have collected data on two additional sets of experimental questions. The completed experiments, which have been prepared for presentation and/or publication, are presented in detail within the body of the report.

In general, the research to date demonstrates that cooperative studying is an effective strategy for learning basic science text and that elements of the cooperative experience appear to positively transfer to (continued)

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Donald F. Dansereau
Texas Christian University

Submitted by:
Robert M. Sasmor
DIRECTOR, BASIC RESEARCH

Approved by:
Edgar M. Johnson
TECHNICAL DIRECTOR

U.S. ARMY RESEARCH INSTITUTE FOR THE BEHAVIORAL AND SOCIAL SCIENCES
5001 Eisenhower Avenue, Alexandria, Virginia 22333

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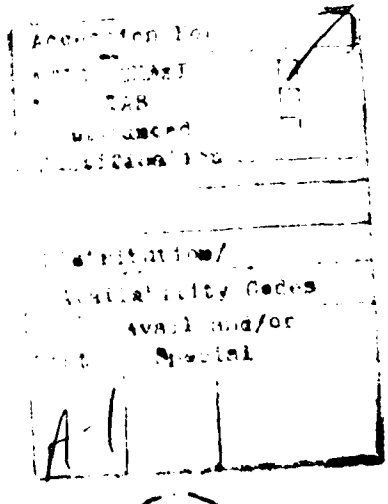
FOREWORD

The Army Research Institute conducts basic research in topical areas relevant to its exploratory and advanced development programs. This report describes basic research toward increasing the effectiveness of educational programs within the Army. The research examines the effects of cooperative studying on initial mastery and retention of information and on subsequent individual learning. It also explores the role of personal characteristics of each member of a learning team on learning outcomes. Such information will serve as the basis for low-cost improvements in instructional design.

EDGAR M. JOHNSON
Technical Director



COOPERATIVE LEARNING: IMPACT ON ACQUISITION OF KNOWLEDGE AND SKILLS

EXECUTIVE SUMMARY

Requirement:

To determine the features of cooperative learning in pairs that lead to significant improvement in mastery and retention of information and transfer of learning strategies to individual learning situations; to determine what individual difference features contribute to cooperative learning outcomes.

Procedure:

In three experiments college students studied excerpts from 2,500-word expository texts and were tested on retention of main ideas and details. Students either studied cooperatively in pairs or individually, with or without experimenter-provided learning strategies. In the cooperative learning strategies both members of the pair read the text, then one summarized it from memory. The partner either simply listened or provided elaborative and corrective feedback to the recaller. Recaller/listener roles were either fixed or alternated. Effects of cooperative learning strategies on individual learning tasks were also assessed in a transfer task. Eight measures of cognitive ability and style were administered and related to learning by both pair members.

Findings:

Cooperative learning was consistently more effective than individual learning from text. This effect was produced by (a) one partner summarizing from memory the material to be learned and (b) the second partner providing corrective or elaborative feedback on the summary. Recallers consistently learned more than listeners. The summary recall and feedback strategy used in cooperative learning transferred positively to subsequent individual learning situations. Finally, it was found that heterogeneous pairs of learners learned better than homogeneous pairs. Specifically, field-independent and high verbal partners facilitated the learning of field-dependent and moderate verbal ability partners, with no adverse consequence to the high ability field-independent partner.

Utilization of Findings:

Cooperative learning strategies are being taught at Ft. Knox in their tank operation and maintenance courses. The strategies are low-cost and easy to teach and have wide application to many learning situations in the Army.

COOPERATIVE LEARNING: IMPACT ON ACQUISITION OF KNOWLEDGE AND SKILLS

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COOPERATIVE LEARNING: IMPACT ON ACQUISITION OF KNOWLEDGE AND SKILLS

OVERVIEW

During the first year of the contract we have completed three sets of experiments. These completed experiments, which have been prepared for presentation or publication, are presented in subsequent sections of this report. In addition, we have collected data on two additional sets of experimental questions: cooperative testing (see Progress Reports 4 and 5) and the impact of elaborative and metacognitive activities during cooperative learning (see Progress Reports 3 and 4). These sets of data are still being examined at this time.

We have presented two papers (the second and fourth sections of this report) based on the results of our experimentation at the Annual Meeting of the American Educational Research Association, April 1983, and are finalizing these papers for submission to the Journal of Educational Psychology. The third completed experiment (see the third section of this report) has been submitted to Cognition and Instruction and is presently under editorial consideration.

In general the research to date demonstrates that cooperative studying is a useful strategy for learning basic science text and that elements of the cooperative experience appear to positively transfer to subsequent individual learning tasks. Differential impacts of elements of the cooperative strategy and individual characteristics of the participants have also been demonstrated. These latter findings have provided bases for developing principles to further improve the cooperative experience.

During the next year we will complete the two experiments (on cooperative testing and on metacognition and elaboration) started during the first year. We will also undertake and complete additional experiments designed to facilitate transfer from cooperative to individual learning and to provide further information on the role of individual differences in cooperative learning and subsequent transfer.

COOPERATIVE LEARNING: IMPACT ON ACQUISITION OF KNOWLEDGE AND SKILLS

Objective

The objective of this research was to investigate the effectiveness of a systematic cooperative learning strategy on (1) the initial acquisition of college-level textbook materials and on (2) the transfer of skills learned in a cooperative situation to individual learning.

Prior research has shown that pairing students for cooperative studying is effective in improving performance in some academic settings (Beaman, Diener, Fraser, & Endreson, 1977; Fraser, Beaman, Diener, & Kelem, 1977; Schermerhorn, Goldschmid, & Shore, 1975). However, other research findings have suggested that while students who study in pairs or small groups learn more effectively than individuals, this increased effectiveness does not transfer to individual learning tasks (Klausmeier, Wiersma, & Harris, 1963; Lemke, Randle, & Robertshaw, 1969).

In general, prior studies of cooperative learning have focused either on the review of previously learned materials or on fairly narrow tasks (i.e., concept attainment tasks) and have given participants only general instructions telling them how they should interactively process the material. Further, these studies have suffered from methodological shortcomings and the lack of a theoretical framework. Controlled laboratory studies are needed to provide a foundation for the development and implementation of cooperative learning as a viable learning tool. The present research was designed as a first step to remedy the drawbacks of prior research on cooperative learning by systematically manipulating the learning strategy used within a dyadic learning situation.

The cooperative learning strategy used in the present research was originally developed as an individual strategy for learning text (Dansereau et al., 1979). This strategy was modified for use in dyadic learning.

In general, the strategy requires each pair member to read approximately 500 words of a 2,500-word passage. One pair member then serves as recaller and attempts to summarize orally from memory what has been learned. The other member of the pair serves as the listener-facilitator and attempts to correct errors in the recall and to further facilitate the organization and storage of the material. The partners alternate the roles of recaller and listener-facilitator as they proceed to subsequent 500-word sections of the passage.

Two experiments using this general procedure were conducted. They focused on the following three questions: (1) Is cooperative learning more effective than individual learning in initial acquisition of college textbook material? (2) Do students learn more effectively in a cooperative learning situation if they are given systematic instructions for pair interaction? (3) Does cooperative learning transfer to individual study?

Experiment 1

The first experiment employed three groups: (1) Group S, the system (formal pair) group; (2) Group N, the no-system (informal pair) group; and (3) Group I, the individual study group. The strategy described earlier was taught to the system group; students in the no-system group were asked to discuss and decide on a method of pair learning; students in the individual group were instructed to use their normal study methods.

Method

Participants. Participants in the study were 60 students (20 subjects per group) recruited from general psychology classes at Texas Christian University. Students received experimental credit for their participation and were paid a small fee.

Procedure. Students were randomly assigned to the three groups. Students in the two pair groups were randomly assigned learning partners.

The study consisted of three sessions. In the first session, students in the system group were given 1 hour of practice in using the strategy with experimenter-provided text material (an excerpt from a general psychology text). The students in the no-system group were given time to develop and practice their own methods, and the students in the individual study group were instructed to practice using their normal study methods. Students in the latter two groups were given 1 hour of practice on the same text materials provided to the system group.

In the second session, all students studied two 2,500-word passages (50 minutes per passage) and were told they would be tested on them in the third session. The students in the two pair groups studied the first passage ("Ecology," extracted from an introductory biology textbook) in pairs and the individual study group studied the passage alone. All students studied the second passage ("Geology," extracted from an introductory geology textbook) individually; the students in both pair groups were instructed to use their methods of pair learning on an individual basis.

In the third session, the students took a set of tests on each passage: an essay test that required them to summarize the passage by noting the main points of the passage and the supporting details, a multiple-choice test (26 and 23 items for the ecology and geology tests, respectively), a cloze test (21 items), and a short-answer test (six items for each passage). All students took both sets of tests as individuals. (Each set of tests took 1 hour.)

Results

All measures were scored according to predetermined keys without knowledge of group affiliation. In addition, the essay questions and short-answer items were scored for reliability by a colleague unfamiliar with the experiment. The reliability coefficients were .91 and .93 between the scorers for each test, respectively.

In order to determine how the subtests of the ecology and geology tests should be combined for further analyses, principal components factor analyses were performed using the data from the individual study group. The results of the factor analyses for the ecology and geology subtests are presented in Table 1. Only one factor emerged for both analyses, indicating that one measure of learning/recall was represented by the subtests for both ecology and geology. The proportion of variance accounted for was .80 for ecology and .79 for geology factor solutions. On the basis of these analyses, a total score for each of the tests was created by summing the scores on the four subtests.

Table 1

Principal Components Factor Solution for Ecology and Geology Subtests

Ecology subtest	F1	Proportion of variance
Cloze	.93	.86
Short-answer	.91	.83
Multiple-choice	.93	.86
Essay	.80	.64
Cumulative proportion of variance	.80	

Geology subtest	F1	Proportion of variance
Cloze	.83	.69
Short-answer	.92	.84
Multiple-choice	.94	.87
Essay	.87	.76
Cumulative proportion of variance	.79	

A one-way analysis of covariance was performed for both the ecology and geology tests, with overall grade point average used as the covariate. The results indicate that there are significant between-group differences for both tests. After removal of the effects of the covariate, for the ecology test $F(2, 56) = 3.65$, $p \leq .03$; for the geology test, with the effects of the covariate removed, $F(2, 56) = 3.39$, $p \leq .05$. Table 2 shows the composite means for the ecology and geology tests and the adjusted cell means for both tests with the effects of the covariate removed. (Supplementary analyses indicated that the homogeneity of regression slopes assumption had not been violated for either test.)

Table 2

Means and Adjusted Cell Means (Effects of Covariate Removed) for Groups S, N, and I on Ecology and Geology Tests

Group	Mean	Adjusted mean with covariate removed
	Ecology test	
S (System pairs) (n = 20)	36.25	36.59
N (No-system pairs) (n = 20)	32.95	33.06
I (Individuals) (n = 20)	29.20	28.75
	Geology test	
S (System pairs) (n = 20)	30.65	30.88
N (No-system pairs) (n = 20)	24.85	24.92
I (Individuals) (n = 20)	25.85	25.54

In order to determine which groups differed significantly, a Tukey's HSD test (Kirk, 1968) for detection of group differences was performed. The results for the ecology test showed Groups S and N to be significantly different from Group I ($p \leq .01$, $p \leq .05$, respectively). The geology test analysis showed that Group S significantly outperformed Groups N and I ($p \leq .01$). All other differences between groups were nonsignificant.

Discussion

In general, the results of this study suggest that cooperative learning is effective in initial acquisition of prose material whether or not students are given specific instructions for pair interaction. This finding extends the previous findings of the effectiveness of pair learning to the initial acquisition of academic material. In addition, the results show that the use of a systematic cooperative learning strategy leads to improved performance in a subsequent individual learning situation. It appears that the systematic pair group employed strategies during pair interaction that transferred to individual learning. This finding suggests that systematic cooperative learning

may serve as an effective vehicle for strategy training. However, because of scheduling problems and limited subject availability at the time the study was conducted, an individual study group that received the experimenter strategy was not included. It is therefore impossible to determine if the observed transfer was a result of the experimenter strategy, the systematic cooperative experience, or a combination of both. As a consequence, a second study was conducted.

Experiment 2

Experiment 2 was conducted in an attempt to replicate and extend the results obtained in Experiment 1. Three groups were employed: (1) Group S-P (system pairs), pairs using the experimenter-provided strategy); (2) Group S-I (system individuals), individuals using the experimenter-provided strategy; and (3) Group O-I (own-strategy individuals), individuals using their own study methods. The experimenter-provided strategy was virtually identical to that of Experiment 1.

Method

Participants. Participants in the study were 87 students recruited from general psychology classes at Texas Christian University; 30 students were in Group S-P, 27 in Group S-I, and 30 in Group O-I. Students were randomly assigned to these groups.

Procedure. The study was conducted in three sessions. During the first session, students in Group S-P were randomly assigned learning partners. Both Group S-P and Group S-I were taught the experimenter-provided strategy. They were asked to practice using the strategy for 1 hour on a 2,000-word passage titled "The Root," which had been selected from an introductory college textbook. Students in Group O-I were asked to practice on the same passage using their normal study methods.

In the second session all students studied two 2,500-word passages (45 minutes per passage) and were told they would be tested on them. (The study time was lowered in this experiment as it was observed that the total amount of time allotted for study in Experiment 1 was not needed.) The students in Group S-P studied the geology passage in pairs and the individual groups, Group S-I and Group O-I, studied alone. All students studied the ecology passage alone. Presenting the passages in reverse order from that used in Experiment 1 allowed for an examination of the potential effect of text content on strategy effectiveness.

The third session was the testing session. The students took an essay test covering the material presented in each passage studied in Session 2. The objective-type tests were eliminated as intervening experimentation suggested that the cloze, short-answer, and multiple-choice tests were not as sensitive as the essay test in measuring prose recall (Collins, Dansereau, Garland, Holley, & McDonald, 1981). All students took both tests individually. In addition, the Group Embedded Figures Test (GEFT) (Oltman, Raskin, & Witkin, 1971) and the Delta Vocabulary Test (Deignan, 1973) were administered following the essay tests. (These were used as covariates in this study since

intervening research demonstrated that these two tests are more sensitive indicators of ability as related to the dependent measures than is grade point average.)

The Delta Vocabulary Test has been used in prior research on prose processing (e.g., Dansereau et al., 1979) and has been shown to correlate ($r \cong .60$) with other measures of verbal ability such as the Scholastic Aptitude Test. Prior research has shown that field-independent individuals, as measured by the GEFT, outperform field-dependent individuals on a variety of text-processing tasks (Brooks & Dansereau, 1980; Collins et al., 1981).

Results

All measures were scored according to predetermined keys without knowledge of group affiliation. A random subset of the essay tests was scored by two colleagues to determine interrater reliability. The following reliability coefficients were obtained: .85, .87, and .83 for the geology test; .82, .85, and .86 for the ecology test.

Since the intent was to look at initial learning and transfer separately, two analyses of covariance were conducted. Results revealed a significant main effect of strategy for the geology passage ($F(2, 84) = 4.62$, $p \leq .01$) and the ecology passage ($F(2, 84) = 2.81$, $p \leq .06$). In order to determine which groups differed significantly, a Tukey's HSD test (Kirk, 1968) for difference of group means was performed. The results of this analysis for the geology test showed Group S-P to be significantly different from Group S-I and Group O-I ($p \leq .01$). The analysis for the ecology test also showed that Group S-P significantly outperformed Group S-I and Group O-I ($p \leq .01$). All other group differences were nonsignificant. The adjusted means and standard deviations for each measure are presented in Table 3.

Discussion

In replication of Experiment 1, the results suggest that students who study in pairs using a systematic learning strategy outperform students who study alone in an initial learning task. In addition, those individuals who studied in pairs during initial learning outperformed the individuals who studied alone in a subsequent individual learning task. These results suggest that the pair members gained beneficial skills/strategies from each other which transferred to an individual learning task.

General Discussion

The combined results of the two experiments indicate that cooperative learning can be used effectively in initial acquisition and that it can facilitate learning skills that are useful in subsequent individual learning. It appears that it is not the strategy or the pair interaction alone, but a combination of the two that enhances an individual's solitary learning following a cooperative experience.

Table 3

Means and Adjusted Cell Means (Effects of Covariate Removed) for Groups S-P, S-I, and O-I on Ecology and Geology Tests

Group	Mean	SD	Adjusted mean	SD
	Geology test			
S-P (System pairs) (n = 30)	.51	.94	.37	.91
S-I (System individuals) (n = 27)	-.28	.81	-.42	.76
O-I (Own-strategy individuals) (n = 30)	-.25	1.08	-.38	1.00
	Ecology test			
S-P (System pairs) (n = 30)	.44	1.05	.28	1.00
S-I (System individuals) (n = 27)	-.18	.94	-.33	.90
O-I (Own-strategy individuals) (n = 30)	-.27	.87	-.41	.84

Although the experiments were conducted in relatively controlled laboratory settings, the passages and tests used to assess treatment effects were derived directly from typical college-level courses. Consequently, it would be expected that the findings from these experiments would generalize to a variety of academic settings. The results appear to be sufficient to warrant field testing of the dyadic cooperative learning technique in school environments. However, there are a number of variables that could be profitably explored in laboratory experiments in order to refine and improve the potency of the cooperative technique. These include variations in the activities of the cooperating students, training duration, ways of assigning partners based on individual differences, and manipulations that would facilitate transfer from cooperative to individual learning.

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COOPERATIVE LEARNING STRATEGIES AND DESCRIPTIVE TEXT PROCESSING: *EFFECTS OF ROLE AND ACTIVITY LEVEL OF LEARNER*

There has been a growing interest in the potential for students to interact with one another in order to improve their acquisition of academic knowledge and skills. Among other things, orchestrated student-student interactions may serve as--

1. Procedures for facilitating the learning and recall of textbook information. Dansereau, McDonald et al. (1979) and McDonald, Dansereau, Garland, Holley, and Collins (1979) provided evidence that students cooperatively studying textbook material in dyads (pairs) performed better on delayed recall and recognition measures than did students studying individually.

2. Vehicles for the transmission of learning strategies, self-knowledge, and life skills. McDonald et al. (1979) found positive transfer of learning skills from a dyadic learning experience to individual studying. Sharan (1980) and Slavin (1980) reviewed research indicating that experiences in cooperative learning subsequently led to positive effects on measures of self-esteem, altruism, and mutual concern.

3. Data sources for evaluating cognitive/educational theories and for analyzing individual differences in processing academic materials. The cooperative learning situation provides a rich collage of textual and extratextual information (e.g., characteristics of the other participant) that can be used to examine styles of storage and recall. For example, taped protocols of dyadic interactions have been used to delineate individual strategies for processing text (McDonald et al., 1979).

The term cooperative learning has generally been applied to situations in which the interactions among students are not based on fixed teacher and learner roles. Usually the participants are viewed as equal partners in the learning experience. Although often indicating positive results (McDonald et al., 1979; Sharan, 1980; Slavin, 1980), these studies on cooperative learning have not attempted to examine systematically critical dimensions of the experience (e.g., interaction and processing strategies, individual differences). Further, these studies have typically suffered from methodological shortcomings and the lack of coherent theoretical frameworks. Controlled laboratory studies using ecologically valid learning materials are needed to provide a basis for the development of viable cooperative learning programs. The present study was designed to be a first step in remedying the drawbacks of prior cooperative learning studies by systematically analyzing the effects of learning (interaction) strategies on the acquisition of scientific knowledge in the context of a dyadic learning situation.

The study by McDonald et al. (1979) provides the basis for the present research. In that study, an individual strategy for learning text developed by Dansereau, Collins et al. (1979) was modified for use in dyadic learning. This strategy required the student pairs to read approximately 500 words of a 2,500-word passage. One student then served as recaller and attempted to summarize orally from memory what had been learned. The other member of the pair served as the listener-facilitator and attempted to correct errors in the recall and facilitate the organization and storage of the material. This process was repeated for each 500-word segment, with the partners alternating

the roles of recaller and listener. Students trained to use this experimenter-provided strategy were compared on the initial acquisition of 2,500-word college-level textbook excerpts with students who developed their own pair learning method and with students studying as individuals. A subsequent test (for which all students studied individually) was conducted to determine the transfer of skills from dyadic to individual study. Results indica ed that pairs of students outperformed the individual study group in initial acquisition, whether or not they were given the experimenter-provided strategy. Students given the experimenter strategy significantly outperformed the other two groups on the transfer test, suggesting that the students acquired skills that transferred from dyadic to individual learning.

In the McDonald et al. (1979) study, the most salient aspect of both the experimenter-provided strategy and the more effective student-generated strategies was oral summarization of what had been read. Ross and DiVesta (1976) conducted a study that directly bears on this issue. In this study one treatment group studied text with the expectation that the group would later present an oral summary. Another group studied the same material without this expectation. Following acquisition, one-third of the subjects in each group presented oral summaries, another third listened to oral summaries, and the remainder did not engage in any review activity. The results indicated that verbal participation facilitated retention and that the highest mean performances were achieved by verbalizers and observers who expected to give an oral summary.

Based on orientation (Frase, 1970) and mathemagenic (Rothkopf, 1970) notions, Ross and DiVesta (1976) suggested that expectation of an oral presentation facilitates acquisition by inducing awareness of objectives and of appropriate learning strategies for achieving those objectives. Further, oral summary, as an activity, provides a review that serves (through further encoding) to consolidate and strengthen what was learned. It also provides relevant feedback about the degree to which mastery and understanding were achieved.

Unlike the Ross and DiVesta (1976) study in which a single summary was required, Dansereau, McDonald et al. (1979) and McDonald et al. (1979) employed cooperative learning strategies requiring multiple oral summaries exchanged between partners. In addition to providing the effects on processing suggested by Ross and DiVesta, the multiple summary approach potentially allows for a subsequent reduction in presentation anxiety due to increased familiarity with the task situation (Zajonc, 1966), an increase in the quality of the production and interpretation of summaries, and an improvement in study processes due to self-generated feedback on the quality of the summaries. The present research was designed to replicate and extend the McDonald et al. (1979) study by assessing the potential effects of multiple summaries described above.

The strategy used in the McDonald et al. (1979) study required the nonsummarizer to assist in monitoring the accuracy and effectiveness of the summary and in elaborating the summary by questioning. Recent research on metacognition has indicated that students of all ages tend to have difficulty monitoring their own cognitive activity (e.g., Baker, 1979; Markman, 1979; Schallert & Kleiman, 1979). Potentially the participants in a cooperative learning situation can aid each other with metacognitive processing. Reder

(1980) has extensively reviewed research in prose comprehension and has made a strong case for the importance of elaboration in comprehension and retention. In cooperative learning the participants can presumably bring to bear different sources of knowledge on which to base enriched elaborations. The present study was also designed to assess the importance of these metacognitive and elaborative functions in a cooperative learning situation.

In summary, the present study had three major purposes:

1. To provide more information on the relative importance of recalling and listening-facilitating during cooperative learning by comparing students assigned fixed roles as "recallers" with those assigned fixed roles as "listeners" and with those who alternate roles.

2. To assess the effectiveness of metacognitive (e.g., comprehension error correcting, importance judging) and elaborative (e.g., integrating information with prior knowledge) activities by comparing dyads who engaged in these activities during studying with dyads who did not.

3. To determine the effectiveness of the cooperative learning techniques in comparison with individual study techniques.

4. To assess the subjective evaluation of the cooperative learning experience as rated by each pair member. These types of evaluations have not been previously examined in laboratory studies of cooperative learning. This is unfortunate because the subjective opinions of the participants are clearly important in the continued, nonsupervised use of this technique.

Method

Participants

One hundred twenty-six students from general psychology classes at Texas Christian University participated in all three sessions of this experiment as part of their course requirement. Participants were randomly assigned to one of five groups: Fixed Role/Summary + Facilitation Activity (n = 36), Fixed Role/Summary Only Activity (n = 36), Alternating Role/Summary + Facilitation Activity (n = 18), Alternating Role/Summary Only Activity (n = 18), and Individual Study Method (18 students used their normal study techniques). Within the four treatment groups, students were randomly assigned to same-sexed pairs.

Materials

The stimulus materials for the assessment phase of this experiment consisted of two 2,500-word scientific passages extracted from college-level introductory science textbooks. Each passage, which had been used in previous studies on prose processing (e.g., Brooks, Dansereau, Holley, & Spurlin, 1981; Dansereau, Holley et al., 1980), dealt with a different nonoverlapping set of concepts; the specific content areas were the theory of plate tectonics and factors influencing ecosystems.

The dependent measures consisted of free recall tests on both passages. The free recall tests required the participant to write down everything remembered from the content of the passages without aid of experimenter-provided cues. The tests were scored for quality and quantity of main and detail ideas according to predetermined keys. The keys were developed based on procedures developed by Meyer (1975) and Holley, Dansereau, McDonald, Garland, and Collins (1979). Used conjunctively, these procedures provided an assessment of the number of superordinate (main) and subordinate (detail) idea units correctly recalled.

The Delta Vocabulary Test (Deignan, 1973) and the Group Embedded Figures Test (GEFT) (Oltman, Raskin, & Witkin, 1971) were employed as measures of individual differences and as covariates in subsequent analysis. The Delta Vocabulary Test has been used in prior research on prose processing (e.g., Dansereau, Collins et al., 1979) and has been shown to correlate moderately (r = .60) with other measures of verbal ability such as the Scholastic Aptitude Test. Prior research has indicated that field-independent individuals outperform field-dependent individuals on a variety of text-processing tasks (Brooks & Dansereau, 1980; Collins, Dansereau, Holley, & Brooks, 1980).

An additional questionnaire, labeled the "Learning Questionnaire," was given to assess the participants' subjective reactions to the cooperative learning experience. They rated their agreement (1 = totally disagree; 7 = totally agree) with 10 statements about the learning experience (e.g., "In general, I learned more from this passage by studying with another person than I would have learned had I studied alone"; "Studying with a partner increased my motivation.")

Procedure

Each of the five groups of participants was given different processing instructions. In the Fixed Role/Summary + Facilitation Activity group, one member of each cooperative pair was randomly assigned the role of recaller. After each approximately 600-word segment of the passage, this person orally summarized from memory the material studied since the last recall. The other member was assigned the role of listener-facilitator and was instructed to correct errors in the recall and to facilitate the organization and storage of the material.

Specific instructions to the pair members were as follows:

1. The recaller summarizes aloud what has been read as completely as possible without looking at the passage. You should try to include all of the important ideas and facts in the summary. Please feel free to use the accompanying paper to draw or chart information while making the summary.

2. After the recaller has completed the summary, the listener should do the following while looking at the passage:

   a. To improve your and your partner's understanding of the passage, correct your partner's summary by discussing the important

information he or she did not include, and by pointing out the ideas or facts that were summarized incorrectly.

b. Help both of you remember the material better by coming up with clever ways of memorizing the important ideas or facts. One way this can be done is by relating the information to earlier material and to other things you know. You also can use drawings and mental pictures to aid memory.

3. The recaller can help the listener in correcting and memorizing the summary.

The Fixed Role/Summary Only pairs were given similar instructions except that the listener was not told to provide any overt input or facilitation to the cooperative interaction.

In the Alternating Role/Summary + Facilitation Activity group, one randomly selected member of each pair served as the recaller for the first segment of the passage, and the other member served as the listener-facilitator. After reading and summarizing each passage segment, the partners switched roles, so that each person recalled two segments and acted as listener-facilitator for two segments. In all other respects the procedure was the same as for the Fixed Role/Summary + Facilitation Activity group. The Alternating Role/Summary Only group was given instructions similar to the Alternating/Summary + Facilitation Activity group except that the listener was not told to provide facilitative activities. The participants in the Individual Study Method group were told to use their normal strategy for processing the text material.

This study was conducted in three 1½-hour sessions. During the first session, the Delta Vocabulary Test was administered, the participants were given instructions about their assigned roles, and the participants subsequently studied the plate tectonics passage for 55 minutes. Two days later, the participants were administered a free recall test on the plate tectonics passage. The participants were asked not to think about or study material related to the passages between sessions. Utilizing the same procedures, the participants then studied the ecosystem passage for 55 minutes. After a 5-day delay, the free recall test on the ecosystem passage was given. In addition, the GEFT and the Learning Questionnaire were administered.

Results

All measures were scored according to predetermined keys without knowledge of group affiliation. A random subset of the free recall tests were independently scored by two persons to determine interrater reliability. The reliability coefficients for plate tectonics main ideas, plate tectonics detail ideas, ecosystem main ideas, and ecosystem detail ideas were .84, .79, .62, and .79, respectively.

Two two-way analyses of covariance (ANCOVAs) (Delta and GEFT as covariates) were conducted on each of the two dependent variables: total main ideas scores from both passages and total detail ideas scores from both passages. Recallers, listeners, and alternaters served as the role factor,

and Summary + Facilitation and Summary Only served as the listener activity factor for both ANCOVAs. Before computing the ANCOVAs, the equality of within-groups regression slopes was tested for each ANCOVA. These analyses indicated that the assumption of homogeneity of within-group regression coefficients was not violated ($Fs \leq .32$, $df = 10, 90$, $ps \geq .97$). The analysis of covariance using total main ideas as the dependent measure revealed that the role and listener activity factors had significant effects ($F(2, 100) = 3.92$, $p < .02$, and $F(1, 100) = 4.09$, $p < .04$, respectively). Means and standard deviations for each of the dependent measures are shown in Table 4. Tukey's post hoc comparisons indicated that the recallers significantly outperformed the listeners ($p < .01$). An examination of Table 4 indicates that the Summary + Facilitation group outperformed the Summary Only group on the total main ideas. No significant effects were found for the ANCOVA using total detail ideas.

Table 4

Adjusted Means and Standard Deviations on Free Recall for Cooperative Learning Groups and Individuals

	Learning activity							
	Summary + Facilitation				Summary Only			
	Total main ideas[b]		Total detail ideas[c]		Total main ideas		Total detail ideas	
Role[a]	M	SD	M	SD	M	SD	M	SD
Recaller	21.27	(5.27)	12.64	(4.84)	19.56	(5.02)	11.60	(4.88)
Listener	16.62	(5.15)	10.22	(3.68)	15.67	(4.75)	10.39	(3.63)
Alternater	19.21	(5.82)	13.24	(4.69)	16.83	(6.74)	11.68	(5.34)
Individual[d]	15.96	(6.59)	9.52	(3.66)	16.16	(6.62)	9.66	(3.49)

Note. Means and standard deviations have been adjusted according to the Delta Vocabulary Test and GEFT.

[a] $N = 18$ in each group.

[b] Total possible points for main ideas = 84.

[c] Total possible points for detail ideas = 86.

[d] The two sets of individuals' scores reported here are from the same 18 subjects. The differences in means are due to the adjustment of the covariates with the Summary + Facilitation group vs. adjustment with the Summary Only group.

To compare the cooperative learning technique with individual study techniques, two one-way ANCOVAs were conducted for each of the two levels of the listener activity factor. Recallers, listeners, alternaters, and individuals were included as the role factor; Delta and GEFT scores were used as the

covariates; and totaled main ideas and totaled detail ideas were included as the dependent measures for each set of ANCOVAs. The within-group regression coefficients were found to be homogeneous for each of the four ANCOVAs ($Fs \leq .83$, $df = 6,60$, $ps > .55$). See Table 4 for means and standard deviations for the Individual group.

The ANCOVA for the Summary + Facilitation group with totaled main ideas as the dependent measure was significant ($F(3, 66) = 3.06$, $p < .03$). Tukey post hoc comparisons revealed that recallers significantly outperformed the individuals on the free recall of main ideas ($p < .05$). No significant effects were obtained for the Summary + Facilitation group with totaled detail ideas as the dependent measure or for the Summary Only group with either dependent measure.

The participants' evaluations of the cooperative learning experience were assessed by the Learning Questionnaire. A principal components analysis produced one factor accounting for 46.6% of the variance. Eight of the 10 questions loaded significantly on this factor (see Table 5). Factor scores were then utilized as the dependent measure in a Role X Listener Activity ANCOVA (Delta and GEFT scores as covariates). The role factor was the only significant effect obtained ($F(2, 100) = 5.17$, $p < .01$). Tukey post hoc comparisons showed that alternaters felt they learned more and had increased motivation and concentration by studying in pairs than did listeners ($p < .01$). Examination of the means (see Table 6) reveals that listeners who had no overt input into the learning experience evaluated the situation as being less beneficial than did any of the other groups.

Discussion

The present study investigated the effects of role and activity of students participating in cooperative dyads on free recall of scientific text passages. The results indicate that students who were assigned the fixed recaller role had significantly higher recall scores for main ideas than students who were assigned the fixed listener role. This finding supports the McDonald et al. (1979) study, the Ross and DiVesta (1976) study, and a number of earlier studies (e.g., Gates, 1917). All of these studies suggest that intermittent recalling (or summarizing) is an activity that increases subsequent recall. This finding is also supported by the alternaters' performance. Individuals in the alternating dyads summarized half of each passage and listened for the other half of the passage. The mean performance of the alternater group is approximately half-way between the mean of the fixed recaller group, who summarized the entire passage, and the mean of the fixed listener group, who did not summarize at all. Therefore, the more the student summarized, the better the student's recall performance.

The mean performance on free recall of detail ideas was similar for all groups. One possible reason for this result is that the recallers focused on summarizing the main ideas rather than the detail ideas. Informal examination of the protocols indicates that this speculation is substantially correct.

The Summary + Facilitation group was found to outperform the Summary Only group on free recall of main ideas. The metacognitive and elaborative

Table 5

Learning Questionnaire Factor Loadings

Question	Loading
In general, I learned more from this passage by studying with another person than I would have learned had I studied alone.	.85
I will remember the material I learned today longer than I would have if I had studied it by myself.	.84
Studying with a partner *increased my concentration.*	.79
Studying with someone helped me learn the main ideas better than if I had studied alone.	.78
Studying with someone helped me learn the details better than if I had studied alone.	.77
Studying with a partner increased my motivation.	.72
I would rather study by myself than with another person.	-.67
I would be willing to study with my pair partner again.	.54

Note. N = 108.

Table 6

Adjusted Means and Standard Deviations on Factor Scores of the Learning Questionnaire

	Learning activity			
	Summary + Facilitation		Summary Only	
Role[a]	M	SD	M	SD
Recaller	505.89	(63.51)	505.20	(58.55)
Listener	482.16	(65.29)	453.89	(77.24)
Alternater	530.65	(82.73)	522.21	(78.37)

Note. Means and standard deviations have been adjusted according to the Delta Vocabulary Test and GEFT.

[a] N = 18 in each group.

activities of the listener appeared to enhance performance of both the listener and recaller. The listener benefited by having overt input into the learning situation, while the recaller benefited from the listener's elaboration and questioning of the summary. Examination of the mean performance on free recall of main ideas indicates that the recallers whose partners provided elaboration had the best performance. Not only does the facilitative activity improve performance, but the combination of summarization and facilitative activity leads to even better performance. To this writer's knowledge, this is the first demonstration of the effects of differential listener activity on recall performance.

Comparison of cooperative learning with individual study techniques showed that recallers in the Summary + Facilitation group outperformed individuals who used their own study techniques. The alternaters in the Summary + Facilitation group also exhibited substantially better mean performance than the individuals, although the results are nonsignificant. (See Table 4 for means and standard deviations.)

The results of the subjective evaluation of the cooperative learning experience revealed that the alternaters were more motivated and enthusiastic about the experience than either the listeners or the recallers. This finding is important for applying cooperative learning techniques to real classroom settings. Even though the recallers had the best performance, the alternaters also had good performance and they evaluated the situation more positively. In the long run, the alternating technique may benefit more of the students than the fixed technique, which allows only half the students to summarize. Additionally, the alternating role, using the facilitative activity for the listener, may be enhanced by having the pairs of students go through the passages twice, allowing each student to summarize the entire passage.

In summary, the cooperative learning procedures have been shown to facilitate recall of textbook information. Specifically, the process of summarizing enhances free recall of the text material's main ideas. Metacognitive and other elaborative activities provided by the listener also increase performance on free recall measures and, in combination with summarization activities, further facilitate performance. These cooperative learning procedures could easily be implemented in a variety of classroom settings. The present results suggest that such implementations are warranted.

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COOPERATIVE LEARNING: THE ROLE OF INDIVIDUAL DIFFERENCES

In recent years, a growing amount of interest and research has focused on the effects of cooperative learning on students' acquisition of academic information (Aronson, Stephan, Sikes, Blaney, & Snapp, 1978; DeVries & Slavin, 1978; Slavin, 1978). Although often indicating positive results, prior studies in cooperative learning have not systematically examined the critical dimensions of the experience: the nature of the pairs' interactions, the processing strategies employed, and the effect of individual learner differences. It is clear that a more detailed and precise understanding of cooperative learning is necessary before its potential as a tool for learning content and skills can be maximized. The present research was designed to be a step in this direction. The effects of relevant individual difference variables in a cooperative, dyadic learning situation are systematically examined.

Research has demonstrated that student interactions, using various cooperative learning methods, facilitate academic achievement (Sharan, 1980; Slavin, 1980). However, these studies have suffered from several shortcomings, including the following: Most of these studies have been conducted in field settings, thereby incorporating little or no experimental control. The cooperative learning groups have varied in size, typically more than two individuals per group, which may have promoted a competitive climate rather than a cooperative one (Beaman, Diener, Frazer, & Enderson, 1977; Klausmeier, Wiersome, & Harris, 1963; Lemke, Randle, & Robertshaw, 1969). Formal methods for processing the material have not been included, so the question remains as to what types of activities promote successful learning in a cooperative situation. In addition, no theoretical underpinnings associated with cognitive approaches to learning have been incorporated. Consequently, very little reliable information has resulted about the important dimensions of cooperative learning.

An attempt to remedy some of these shortcomings involved a systematic manipulation of a learning strategy in a controlled dyadic situation (McDonald, Dansereau, Garland, Holley, & Collins, 1979). This strategy required the student partners to read a 2,500-word passage excerpt from an introductory college-level textbook. The passage was organized in 500-word sections. One student served as recaller and orally summarized from memory what had been learned. The student's partner served as the listener-facilitator and attempted to correct errors in the recall and to facilitate the organization and storage of the material. This process was repeated over each section of the text with each partner alternating the roles of recaller and listener. Students using this strategy outperformed those students who studied as individuals using their normal study methods. In addition, the skills gained in the pair learning situation transferred to individual study.

Spurlin, Dansereau, Larson, and Brooks (1982) replicated and extended this research by incorporating additional treatment conditions. These conditions included cooperative pairs who alternated recaller and listener roles and pairs in which members maintained fixed roles throughout the study session. In addition, the listener-facilitator was either an active or passive participant in the process. After the summarizations, the active listener corrected and questioned the recall whereas the passive listener provided no feedback. The results indicated that on recall of text main ideas, fixed

recallers performed better than fixed listeners, and pairs incorporating an active listener outperformed those that did not.

These studies provided some specification of the dimensions of cooperative learning. It appears that the students' active summarizations and the partners' questioning and correcting of the summaries facilitate the acquisition and storage of text material in student-student interactions.

However, even within these more controlled studies there is substantial variation in performance measures among individuals receiving the same cooperative learning experiences. It is very likely that this within-group variation is due to individual differences associated with aptitude, style, prior knowledge, and personality variables. This variation may be due not only to an individual's characteristics but also to the characteristics of that individual's partner. Because cooperative learning is based on student-student interactions, it may be that the aptitudes and styles of each member of the pair influence the impact of this strategy on the students' acquisition of information. As stated previously, prior research has not systematically explored the role of individual differences in cooperative learning.

The individual difference variables selected for the present study are drawn from the domains of cognitive style, verbal ability, prior knowledge, and personality. Using a modified version of the cooperative learning strategy developed by McDonald et al. (1979), the present study examined the effects of individual differences on recall performance in a pair learning situation. In addition to explaining individual differences, the present experiment was also designed to replicate the finding (McDonald et al., 1979) that cooperative learning is more effective than individual learning on the initial acquisition of text material.

The prior research on individual differences in group interaction does not provide a clear basis for developing formal hypotheses. In some cases, it appears that increasing the homogeneity of the participants leads to improved performance; while in others, heterogeneity appears to facilitate performance. For example, research has indicated that when interacting individuals have the same cognitive style, they learn more from one another and view each other more positively than do individuals who have different cognitive styles (DeStefano, 1970). However, research in a different domain has indicated that discrepant ability levels lead to better performance than similar ability levels (Frick, 1973; Webb, 1977). This research suggests that in heterogeneous groups, in which individuals with high ability assume the role of teacher, may have a facilitative effect on the performance of both individuals. When students with high ability are matched, they may be put in a competing position (both may want to explain the material), and matched students with low ability may only confuse each other. As a consequence of the equivocality of the research on individual differences in task groups, no formal hypotheses were generated about the role of these variables in cooperative learning.

A discussion of the measures chosen for the study follows. The measures were selected based on the relationship each may have to academic performance.

Field Dependence-Independence. Research on field dependence-independence has demonstrated that clear differences exist in the information processing

capabilities of field-dependent and field-independent individuals. According to the dictates of this construct, the field-dependent individual thinks globally, confuses figure-ground relationships, has difficulty abstracting relevant from irrelevant information in a visual display, tends to store information in memory in general overlapping categories rather than in discrete categories, and may have difficulty structuring information in a well-organized manner. At the other end of the continuum, the field-independent individual thinks analytically, can distinguish relevant items as discrete from their background, can restructure information in memory in an organized manner, and can impose structure on a disorganized field (Witkin, Moore, Goodenough, & Cox, 1977).

Cognitive Complexity. Cognitively simple individuals may be characterized as people who do not make fine discriminations among constructs, use concrete labels in generating constructs, are more likely to assume that another's behavior is similar to their own, and are unable to integrate discrepant information. In comparison, cognitively complex individuals differentiate among concepts, use abstract labels in generating constructs, assume other people are less similar to themselves, are able to make more inferences from a set of information than are cognitively simple individuals, are more likely to impose greater complexity on ambiguous material, and are able to integrate discrepant information (Epting, Wilkins, & Margules, 1972; Leutner, Landfield, & Barr, 1974; Tripoldi & Bieri, 1966).

Educational Set. The Educational Set Scale (ESS) was designed to assess an individual's preferred approach in learning academic material. It is suggested that some students prefer to learn general concepts before facts (conceptually set) while others prefer to learn facts before concepts (factually set) (Siegel & Siegel, 1967).

Verbal Ability and Prior Knowledge. It would seem obvious that verbal ability and prior knowledge would have an impact on the learning situation. That is, an individual's ability to articulate and communicate the material he or she has read would be relevant to how well the material is learned. It was expected that prior knowledge of the content areas involved in this study would enhance learning by enabling the students to elaborate on the material being studied.

Internal-External Locus of Control. Rotter's (1966) I-E scale was developed to assess the extent to which individuals differ in their belief that reinforcement is controlled by their own behavior or personal characteristics (internal) or by luck, fate, chance, or powerful others (external). Research on problem solving has indicated that individuals who believe in an internal locus of control are superior to those who believe in an external locus in utilizing information, attending to information-relevant cues and avoiding task-irrelevant thoughts, discovering the rule involved in a problem-solving task, and incidental learning (DuCette & Wolk, 1973; Lefcourt & Wine, 1969; Wolk & DuCette, 1974).

Test Anxiety. It has been demonstrated that students exhibiting high degrees of test anxiety perform less well on academic tasks than students who are not test anxious (Sarason, 1975; Wine, 1971). Research has shown that subjects with high test anxiety may experience thoughts that are

irrelevant to the task and that may compete with test-taking performance (Wine, 1971).

To summarize, this study examined the influence of homogeneity-heterogeneity of style, aptitude, prior knowledge, and personality in a dyadic learning situation. The following questions provided the focus of this study:

1. Do students who study cooperatively outperform those who study individually?

2. How do the individuals' and partners' scores on each measure of individual difference affect the cooperative learning experience as measured by recall on an essay test?

Method

Participants

Participants in the study were 206 students from 15 sections of the learning strategy classes at Texas A & M University. One hundred eighty-one students were randomly assigned to the cooperative learning group and 26 were assigned to the individual study group. Students received partial course credit for their participation.

Materials

The stimulus material for the test phases of the experiment consisted of a 2,500-word scientific passage on plate tectonics extracted from an introductory geology textbook. This passage had been used in previous studies in prose processing (Dansereau et al., 1980; Spurlin et al., 1982; Brooks, Dansereau, Spurlin, & Holley, 1982).

The dependent measure was a free recall test in which the participant was required to write from memory as much as possible about the content of the passage.

The Group Embedded Figures Test (GEFT) (Oltman, Raskin, & Witkin, 1971), the REP Test (Bieri, 1955), the ESS (Siegel & Siegel, 1967), the Delta Vocabulary Test (Deignan, 1973), two prior knowledge tests that assess knowledge about plate tectonics, the Rotter Internal/External Locus of Control Scale (Rotter, 1966), and the Test Anxiety Scale (TAS) (Sarason, 1956) were used as the measures of individual differences.

The GEFT requires individuals to detect simple shapes within complex figures. Those who perform this task well are designated as field independent whereas those who do the task poorly are classified as field dependent.

The REP Test measures cognitive complexity. The task is to rate 10 roles (e.g., mother, father, friend of the opposite sex), choosing from 10 experimenter-provided bipolar constructs (e.g., outgoing-shy). The score

for cognitive complexity is derived by comparing the ratings. The higher the score, the lower the cognitive complexity.

A modified version of the original 93-item, forced-choice ESS was selected for this study (Holley, Dansereau, & Fenker, 1981). This test requires the individual to select from four alternatives the content area he or she would most prefer to study (the alternatives range from conceptual information to factual information).

The Delta Vocabulary Test, a 46-item multiple-choice test, was used as a measure of verbal ability. Prior research has shown this measure to be moderately related (r = .60) to other more time-consuming measures of verbal aptitude such as the Scholastic Aptitude Test.

To assess prior knowledge two questionnaires were developed. The General Knowledge Questionnaire (GEN) is composed of 48 multiple-choice items chosen from the target passage and related domains. The Academic Knowledge Questionnaire (ACAK) is composed of 12 items attempting to assess an individual's judgment of his or her familiarity with concepts derived from several content areas. The task is to rate on a 7-point scale the degree of familiarity with the given concepts.

Rotter's I-E scale was administered to assess internal-external locus of control. This test consists of 23 forced-choice items.

To assess test anxiety, a slightly modified version of the 37-item TAS was used.

Procedure

Instructors of the class sections were trained to conduct this study. For the cooperative study group, the experiment consisted of seven sessions. The first session was devoted to the administration of the measures of individual difference. Four sessions were devoted to training, one session to reading and studying for tests, and one session to taking tests.

The cooperative learning strategy taught was a modified version of that developed by Dansereau et al. (1980). Partners took turns playing the roles of recaller and listener-facilitator for 500-word segments of the passage being studied. The recaller's role was to summarize orally the segment while the listener-facilitator corrected errors and tried to help the recaller organize and store the material. During training, subjects used their own textbooks as practice materials.

An attempt was made to assign students to same-sexed pairs and maintain the original pair assignments. However, due to absenteeism and the imbalance of males and females this was not possible in all cases.

Session 1. All students filled out consent forms and were administered the Rotter I-E scale, the Delta Vocabulary Test, the prior knowledge questionnaires, the GEFT, the ESS, the TAS, and the REP Test.

Session 2. Students read the cooperative learning instructions and studied a textbook of their choosing for 35 minutes. The instructors monitored the pairs to ensure that they were following instructions.

Sessions 3-5. Students were reminded of the cooperative learning instructions and given 35 minutes to practice the method on their own textbook material.

Session 6. Pairs were given cooperative learning instructions and read and studied the plate tectonics passage for 45 minutes.

Session 7. After a 2-day delay, the free recall test on the plate tectonics passage was administered. Students were not paired for the testing.

All subjects in the individual study group completed the individual difference measures and were asked to use their normal study methods during all remaining sessions.

Results

All dependent measures were scored for main and detail ideas by the experimenter and two colleagues according to predetermined keys without knowledge of group affiliation. Interrater reliability for the free recall content scores was assessed by having each rater score a random subset (20) of the exams. Pearson product-moment correlations were computed; the correlation coefficients were .99, .95, and .92 for main ideas and .98, .90, and .86 for detail ideas.

To determine the effectiveness of cooperative learning in comparison with individual learning, a test comparing the two groups' performances on free recall of main and detail ideas was conducted. The results of this test indicated that cooperative learners recalled more main ideas ($t(204) = 4.05$, $p < .05$) and detail ideas ($t(204) = 3.62$, $p < .05$) than individual learners recalled. The means and standard deviations for each group are reported in Table 7.

Table 7

Means and Standard Deviations for Cooperative Learning Group vs. Control Group on Recall of Main Ideas and Detail Ideas

Group	Measure of recall	
	Main ideas	Detail ideas
Cooperative learning ($n = 181$)		
Mean	11.02	3.82
SD	5.74	3.03
Control ($n = 25$)		
Mean	6.15	1.56
SD	4.57	1.85

Because the measures of individual difference were not administered in three of the classes, those sections were excluded from further analyses. Within the remaining sections, some participants failed to complete the TAS and the ESS. The degrees of freedom for these measures are therefore reduced in subsequent analyses.

Although the proposed analysis plan included an examination of the individual difference scores as predictors of individual study performance, too few participants were assigned to this condition to estimate reliably the parameters of interest. Therefore the control group was excluded from further analyses. The means, standard deviations, and intercorrelations of the variables for participants assigned to the cooperative learning condition are shown in Table 8.

A series of analyses were performed in order to assess the relationship between individual's essay performance and the scores obtained on the measures of individual difference for the individual and the partner. As a first step, linear regressions were computed for each measure. The individual's score and the partner's score on each measure of individual difference were entered to predict the individual's performance on the essay test for both main and detail ideas.

As noted in Table 9, the individual's score on the GEFT, Delta Vocabulary Test, and TAS significantly predicted recall of detail ideas ($p < .05$ in all cases). In addition, the partner's GEFT scores significantly ($p < .01$) contributed to the individual's recall of detail ideas. The individual's score on the Delta Vocabulary Test and TAS also significantly ($p < .01$) predicted recall of main ideas. All other predictions were nonsignificant.

Examination of the raw data plots indicated discontinuities in the relationship between some of the measures of individual difference and essay performance. Based on these observations, it was concluded that a curvilinear function might more accurately represent the relationships between some of these variables. To determine the best fitting form of the relationship, several data transformations were performed and entered into linear regression analyses. Among those employed were square, cube, and logarithmic transformations.

In examining these analyses, it appeared that in general the log-log functions provided the best predictability. Table 10 presents the results of the log-log analyses.

The individual's scores on the GEFT, Delta Vocabulary Test, and Academic Knowledge Questionnaire significantly ($p < .05$) predicted recall of detail ideas. The partner's score on the GEFT also contributed significantly ($p < .01$) to the equation. In addition, the individual's scores on the GEFT, Delta Vocabulary Test, and TAS significantly ($p < .01$) predicted recall of main ideas.

In order to clarify the nature of the relationship on those measures found to be significant, a series of linear regression analyses was performed on subsets of data for each measure.

Table 8

Intercorrelations, Means, and Standard Deviations of All Measures

	GEFT	REP	ESS	Delta	GEN	ACAK	I-E	TAS	Main	Detail
GEFT										
REP	-.19									
ESS	.12	-.32								
Delta	.06	-.23	.28							
GEN	.11	-.12	.09	.28						
ACAK	.13	-.02	.06	.14	.15					
I-E	-.19	.00	-.11	.14	.00	-.11				
TAS	-.19	-.05	-.04	-.06	.09	.01	.11			
Main	.16	-.01	.06	.29	.10	.02	-.09	-.27		
Detail	.25	-.08	.02	.20	.08	.13	-.05	-.19	.42	
Mean	11.00	125.46	37.51	24.96	9.34	33.57	8.11	98.22	12.18	4.51
SD	4.32	39.61	4.73	5.99	2.96	8.59	3.63	8.98	5.76	3.16
N	88	88	85	88	88	88	88	86	88	88

Table 9

Linear Regression Analyses on All Measures: Cooperative Learning Group

Measure of individual difference	Measure of recall					
	Detail ideas			Main ideas		
	Beta	F	df	Beta	F	df
GEFT	.27	7.37**	(2,85)	.16	2.46	(2,85)
PGEFT	.22	4.97**	(2,85)	.00	.01	(2,85)
	R^2 = .11*			R^2 = .02		
Delta	.21	4.05**	(2,85)	.29	7.96**	(2,85)
PDelta	.10	.98	(2,85)	.06	-.01	(2,85)
	R^2 = .05			R^2 = .09*		
ESS	.00	.05	(2,79)	.00	.44	(2,79)
PESS	.00	.20	(2,79)	.00	.83	(2,79)
	R^2 = .00			R^2 = .01		
REP	-.13	1.58	(2,85)	.00	.04	(2,85)
PREP	.00	.21	(2,85)	.00	.08	(2,85)
	R^2 = .02			R^2 = .01		
TAS	-.21	3.75*	(2,81)	-.28	7.18**	(2,81)
PTAS	-.14	1.65	(2,81)	-.10	.87	(2,81)
	R^2 = .05			R^2 = .08*		
I-E	.00	.34	(2,85)	.00	.01	(2,81)
PI-E	-.11	1.15	(2,85)	.00	.05	(2,81)
	R^2 = .01			R^2 = .00		
ACAK	.00	.00	(2,85)	.00	.01	(2,85)
PACAK	.13	1.57	(2,85)	.13	1.49	(2,85)
	R^2 = .01			R^2 = .01		
GEN	.00	.69	(2,85)	.00	.99	(2,85)
PGEN	.00	.07	(2,85)	.10	.00	(2,85)
	R^2 = .00			R^2 = .01		

*$p < .05$.

**$p < .01$.

Table 10

Linear Regression Analyses Using Log-Log Transformations: Cooperative Learning Group

Measure of individual difference	Measure of recall					
	Detail ideas			Main ideas		
	Beta	F	df	Beta	F	df
GEFT	.33	11.72**	(2,85)	.23	5.05**	(2,85)
PGEFT	.21	4.74*	(2,85)	.00	.22	(2,85)
	R^2 = .17**			R^2 = .05		
Delta	.20	3.62*	(2,85)	.61	9.54**	(2,85)
PDelta	.10	.98	(2,85)	.10	1.00	(2,85)
	R^2 = .04			R^2 = .11**		
ESS	.00	.08	(2,79)	.00	.23	(2,79)
PESS	.00	.46	(2,79)	.00	.52	(2,79)
	R^2 = .00			R^2 = .00		
REP	-.15	1.74	(2,85)	.00	.03	(2,85)
PREP	.00	.06	(2,85)	.15	.53	(2,85)
	R^2 = .02			R^2 = .00		
TAS	-.21	4.02*	(2,81)	-.26	6.07**	(2,81)
PTAS	-.15	2.02	(2,81)	-.13	1.65	(2,81)
	R^2 = .06			R^2 = .07*		
I-E	-.13	1.57	(2,85)	.00	.00	(2,81)
PI-E	-.10	.93	(2,85)	.00	.18	(2,81)
	R^2 = .02			R^2 = .00		
ACAK	.22	5.02**	(2,85)	.00	.00	(2,85)
PACAK	.00	.12	(2,85)	.00	.29	(2,85)
	R^2 = .05*			R^2 = .00		
GEN	.13	2.68	(2,85)	.12	1.22	(2,85)
PGEN	.00	.63	(2,85)	.00	.35	(2,85)
	R^2 = .03			R^2 = .02		

*$p < .05$.

**$p < .01$.

The data on each measure of individual difference were divided into overlapping subsets representing the upper, middle, and lower 50%. Linear regression analyses with the raw, untransformed data were then conducted for each subset. As noted in Table 11, the GEFT significantly ($p < .01$) predicted recall of detail ideas for the individuals scoring in the lower half. Also, the partner's GEFT score contributed significantly ($p < .01$) to the recall score for individuals scoring in the lower half of the GEFT. The analyses of the Delta Vocabulary Test subsets demonstrate significant predictability in the middle 50% for both the individual ($p < .05$) and partner ($p < .05$) on detail ideas. For both the GEFT and Delta Vocabulary Test all beta weights were positive, indicating improved performance with increased scores on these two measures.

As shown in Table 12, the TAS scores of individuals who scored in the upper half of the TAS significantly predicted recall of main ideas ($p < .01$). It should be noted that the beta weights were negative, indicating that those who scored lower on the TAS showed better recall than those who scored as being more test anxious. All other comparisons were nonsignificant.

To determine which variables or combinations of variables were most salient in the cooperative learning task, all variables that were found to be significant in the log-log transformations were entered into a single, multiple regression equation (all data were subjected to log-log transformations). Based on these results, which are reported in Table 13, the individuals' GEFT scores and Delta scores make significant predictions for recall of detail ideas ($p < .05$), as do the partners' scores on the GEFT ($p < .01$). For main ideas, performance is significantly predicted by the individual's GEFT score ($p < .05$) and Delta Vocabulary Test score ($p < .01$).

Discussion

The results of the present study indicate that the use of cooperative learning in the acquisition of text material leads to improved performance in comparison with individual study methods. In addition, the results demonstrate that performance can be predicted by an individual's scores on several measures of individual difference and to some extent by the scores of the individual's partner. The following discussion will address the two questions posed earlier, which provided the focus of this research.

1. Do students who study cooperatively outperform those who study individually? In replication of previous research (McDonald et al., 1979; Spurlin et al., 1982), the results of the present study confirm the prediction that pairs of students who study cooperatively outperform individuals who use their normal study methods as measured by recall of main ideas and detail ideas.

2. How do the individuals' and partners' scores on each measure of individual difference affect the cooperative learning experience as measured by recall on an essay test? The individuals' scores and the partners' scores on the I-E scale, the REP Test, the ESS, and the General Knowledge Questionnaire did not significantly predict recall in any of the analyses. These factors do not appear to be salient contributors to this type of learning.

Table 11

Regression Analyses on Detail Ideas Using Data Subsets:
Cooperative Learning Group

Measure of individual difference	Subset: Low			Middle			High		
	Beta	F	df	Beta	F	df	Beta	F	df
GEFT	.43	11.22**	(2,41)	.20	1.84	(2,41)	.19	1.56	(2,41)
PGEFT	.34	6.96**	(2,41)	.25	1.70	(2,41)	.03	.02	(2,41)
	R^2 = .35**			R^2 = .12			R^2 = .03		
Delta	.08	.23	(2,41)	.29	4.20*	(2,41)	-.12	.59	(2,41)
PDelta	.05	.04	(2,41)	.27	3.61*	(2,41)	.07	.22	(2,41)
	R^2 = .00			R^2 = .15			R^2 = .02		
ESS	.03	.03	(2,40)	.22	1.93	(2,40)	-.10	.39	(2,40)
PESS	.08	.27	(2,40)	.01	.00	(2,40)	.04	.06	(2,40)
	R^2 = .00			R^2 = .04			R^2 = .01		
REP	-.16	1.00	(2,41)	.14	.72	(2,41)	-.20	1.98	(2,41)
PREP	.12	.60	(2,41)	-.13	.68	(2,41)	-.29	3.18	(2,41)
	R^2 = .03			R^2 = .02			R^2 = .14		
TAS	-.08	.23	(2,40)	-.06	.15	(2,40)	-.21	1.84	(2,40)
PTAS	-.20	1.66	(2,40)	-.24	2.25	(2,40)	-.05	.10	(2,40)
	R^2 = .04			R^2 = .05			R^2 = .04		
I-E	-.32	3.21	(2,41)	-.20	1.69	(2,41)	-.03	.04	(2,41)
PI-E	-.04	1.00	(2,41)	-.11	.49	(2,41)	-.14	.79	(2,41)
	R^2 = .11			R^2 = .04			R^2 = .01		
ACAK	.15	.96	(2,41)	.16	1.04	(2,41)	-.12	.57	(2,41)
PACAK	-.12	.53	(2,41)	-.09	.32	(2,41)	.11	.51	(2,41)
	R^2 = .03			R^2 = .03			R^2 = .02		
GEN	.09	.37	(2,41)	.11	.47	(2,41)	-.20	1.71	(2,41)
PGEN	-.10	.40	(2,41)	-.07	.16	(2,41)	.03	.04	(2,41)
	R^2 = .00			R^2 = .04			R^2 = .01		

*p < .05.

**p < .01.

Table 12

Regression Analyses on Main Ideas Using Data Subsets:
Cooperative Learning Group

Measure of individual difference	Subset: Low			Middle			High		
	Beta	F	df	Beta	F	df	Beta	F	df
GEFT	.22	1.98	(2,41)	.17	1.18	(2,41)	.02	.19	(2,41)
PGEFT	.09	.34	(2,41)	.05	.09	(2,41)	-.04	.09	(2,41)
	R^2 = .01			R^2 = .02			R^2 = .02		
Delta	.17	1.27	(2,41)	.26	2.99	(2,41)	-.06	.12	(2,41)
PDelta	-.14	.84	(2,41)	.08	.25	(2,41)	-.02	.01	(2,41)
	R^2 = .05			R^2 = .07			R^2 = .00		
ESS	.06	.15	(2,40)	.16	1.06	(2,40)	.10	.33	(2,40)
PESS	-.14	.77	(2,40)	-.24	2.62	(2,40)	-.01	.21	(2,40)
	R^2 = .02			R^2 = .08			R^2 = .01		
REP	.17	1.21	(2,41)	-.08	.27	(2,41)	-.05	.08	(2,41)
PREP	.23	2.37	(2,41)	.10	.42	(2,41)	-.11	.49	(2,41)
	R^2 = .09			R^2 = .01			R^2 = .01		
TAS	-.13	.68	(2,40)	-.04	.06	(2,40)	-.42	8.53**	(2,40)
PTAS	-.06	.15	(2,40)	-.23	2.16	(2,40)	-.09	.42	(2,40)
	R^2 = .01			R^2 = .05			R^2 = .18**		
I-E	-.17	1.14	(2,41)	.15	.94	(2,41)	-.03	.03	(2,41)
PI-E	-.01	.00	(2,41)	.07	.18	(2,41)	.03	.03	(2,41)
	R^2 = .02			R^2 = .03			R^2 = .00		
ACAK	.17	1.16	(2,41)	.08	.26	(2,41)	-.04	.05	(2,41)
PACAK	.09	.36	(2,41)	.18	1.36	(2,41)	.17	1.23	(2,41)
	R^2 = .04			R^2 = .03			R^2 = .03		
GEN	-.21	1.87	(2,41)	.16	.88	(2,41)	.12	.59	(2,41)
PGEN	-.16	1.08	(2,41)	-.01	.00	(2,41)	.13	.67	(2,41)
	R^2 = .06			R^2 = .02			R^2 = .02		

*$p < .05$.

**$p < .01$.

Table 13

Multiple Linear Regression Using Log-Log Transformations: Cooperative Learning Group

Measure of individual difference	Measure of recall					
	Detail ideas			Main ideas		
	Beta	F	df	Beta	F	df
LGEFT	.38	9.20**	(5,82)	.19	3.90*	(5,82)
LPGEFT	.28	5.02**	(5,82)			
LDELTA	.17	3.25*	(5,82)	.30	9.21**	(5,82)
LTAS	.00	.50	(5,82)	-.11	1.32	(5,82)
LACAK	.13	1.85	(5,82)			
	R^2 = .23**			R^2 = .16**		

*p < .05.

**p < .01.

In separate regression analyses it was found that the individual's scores on the GEFT, Delta Vocabulary Test, and Academic Knowledge Questionnaire were significantly related to the recall of detail ideas. Further, the individual's GEFT, Delta, and TAS scores also significantly predicted the recall of main ideas. However, when these measures were combined in a single multiple regression equation, the TAS and Academic Knowledge Questionnaire did not significantly contribute to recall of either main or detail ideas. Therefore, the following discussion will be focused on the GEFT and the Delta Vocabulary Test.

Cognitive Style

The results indicate that individuals with higher GEFT scores tend to recall more main ideas and details. The evidence suggests that the attribute of field independence is particularly beneficial in the recall of detail ideas for those individuals scoring below the median. As the individual's GEFT score increases above the median, there does not tend to be an accompanying increase in recall.

In addition, the results of the log-log transformation suggest that having a field-independent partner facilitates the individual's recall of detail ideas. Further, as the partner tends to be more field independent, individuals who score below the median on the GEFT tend to show better performance.

This evidence suggests that the cooperative learning experience may be most effective in facilitating recall when pairs are heterogeneous on this measure. That is, a field-dependent individual should benefit most from the cooperative learning situation if paired with a field-independent individual.

It appears that field-independent individuals (i.e., those scoring above the median) are not adversely affected by being paired with field-dependent partners. Field-independent individuals may be better able to discriminate important from irrelevant information while simultaneously serving as role models in this process for field-dependent individuals.

Ability

Those individuals who demonstrated high ability showed better recall than those with low ability. In only one analysis did the partner's score contribute significantly to the individual's recall. Within the analyses utilizing lower, middle, and upper subgroups, those individuals who scored in the middle range on the Delta Vocabulary Test showed improved performance on the recall of detail ideas when paired with a partner who demonstrated high verbal ability. It may be that the transformations employed were not appropriate for capturing the influence the partner's ability level has on the individual's recall of detail ideas.

In a pair learning situation, forming heterogeneous pairs appears to be most crucial for those individuals who score in the middle range on the Delta Vocabulary Test. Under these conditions, an individual who exhibits relatively low verbal ability may be helped most in performance by a partner who exhibits high verbal ability. For those scoring outside of this range, it may make no significant difference in recall if homogeneous or heterogeneous pairs are formed.

The individuals who score low in verbal ability may simply not be able to understand the material well enough to be helped by a pair member. By the same token, those individuals who score high in verbal ability have skills adequate to learn the material without really being affected by the learning strategy. However, those individuals who score in the middle range seem to have some skill which appears to be facilitated by those individuals who score high in verbal ability. These individuals seem to be in the best position for learning from a pair partner.

In considering individual differences in cooperative learning, the results of this study suggest that the optimal pairing strategy to facilitate the individual's recall performance would be to form heterogeneous pairs on both the attribute of field dependence and verbal ability. That is, pairing an individual who is field dependent and who tends to demonstrate moderate verbal ability with a field-independent partner of high verbal ability would aid the former's understanding of the material and not adversely affect the latter's performance.

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